Scalar Mesons and Glueballs

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Recently the search for exotic meson resonances containing constituent gluons g has made dramatic progress. By now glueballs, $q\bar{q}g$ states additional to the normal quark-antiquark $q\bar{q}$ mesons, are firmly predicted by large scale lattice QCD calculations. In the Crystal Barrel (CB) experiment at LEAR (CERN) three new scalar mesons $f_0(1370)$, $a_0(1450)$ and $f_0(1500)$ have been discovered in $\bar{p}p$ annihilation [1]. The $f_0(1500)$ is difficult to interpret as a $q\bar{q}$ state. It is identified as a promising candidate for the long-sought ground state of the glueball spectrum.

While hybrids or 4-quark states may stick out with exotic J^{PC} quantum numbers not accessible to $q\bar{q}$ states [2], theory predicts the lowest glueball to be a scalar f_0 0^{++} state, which might mix with $q\bar{q}$ scalars. Thus it is crucial to establish the correct classification of scalars and to study their properties as completely as possible.

The new scalars were discovered in their neutral π^0 and η decays. In order to clarify their flavor and gluon structure, their $K\bar{K}$ coupling has to be studied with similar precision. This was achieved by selecting $\bar{p}p$ annihilation with a missing K_L and by a special K_S trigger, based on a silicon vertex detector.

The K_L analyses prove that $f_0(1500)$ couples only weakly to $K\bar{K}$. Thus interpretations that $f_0(1500)$ might be a dominantly $s\bar{s}$ state become highly unlikely. The new $a_0(1450)$ is also observed in its $K_LK^{\pm}$ decay in the CB data with parameters consistent with its $\pi^0\eta$ decay. Not all puzzles are settled yet, as a recent measurement of the Obelix collaboration finds a narrow a_0 at lower mass. Further clarification awaits the analysis of our very clean and high-statistics data obtained with the K_S trigger (see fig.1,2).

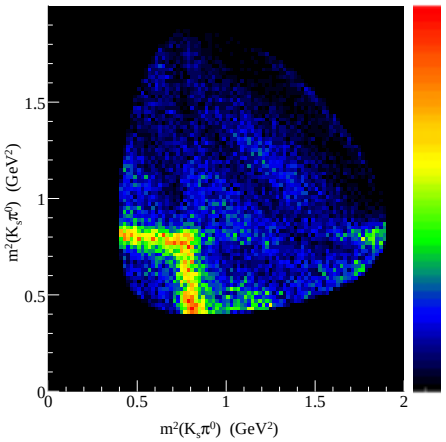

Figure 1: Dalitz plot for $\bar{p}p \to K_S K_S \pi^0$. Both isospin I=0 and I=1 $K\bar{K}$ resonances contribute.

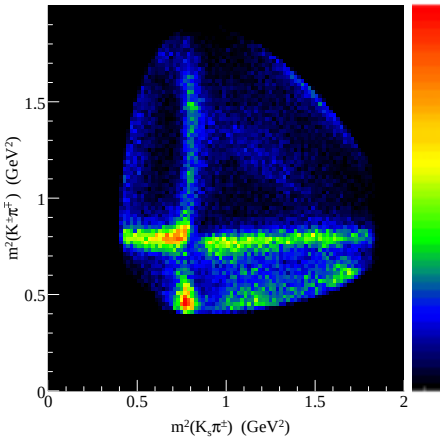

Figure 2: Dalitz plot for $\bar{p}p \to K_S K^{\pm}\pi^{\mp}$. Only I=1 $K\bar{K}$ resonances contribute. Both figures preliminary results without acceptance correction. Data and partial wave analyses performed in Berkeley.

Footnotes and References

*webpage: http://www.phys.cmu.edu/cb/cb.html

[1] C. Amsler et al., Phys. Lett. B335 (1995) 425, c.f. R.M. Barnett et al. (PDG), Phys. Rev. D 54 (1996) 1

[2] see related contribution in this annual report